IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 5, Issue 5, May 2018

Partial Replacement of Cement by Using Refused Glass Powder in Concrete for Strengthening

Ms. Shweta N. Rokdey[1], Mr. G. D. Dhawale[2], Ms. S.A. Wagh[3]

M. Tech Student, Department of Civil Engineering, B.D.College of Engineering,Wardha, India [1]

Professor, Department of Civil Engineering, B.D.College of Engineering,Wardha, India[2]

Asst. Professor, Department of Civil Engineering, B.D.College of Engineering,Wardha, India[3]

Abstract: The sheet glass cutting industries producing waste glass material, which are not recycled at current and usually deliver to landfills for disposal. By using glass powder in concrete as a partial replacement is an interesting possibility for economy on waste disposal sites and conservation of natural resources. Glass is unbalanced in the alkaline environment of concrete and could cause lethal alkali silica reaction problems. This property of glass has been used to advantage by grinding it into a fine powder for incorporation into concrete as a pozzolanic material. In laboratory experiments it can contain the alkalireactivity of coarser glass particles, as well as that of natural reactive aggregates. It undergoes beneficial pozzolanic reactions in the concrete and could replace up to 30% of cement in several concrete mixes with satisfactory strength development. Waste glass powder in proper proportion can be used to resist chemical attack. The aim of this project work is to use glass powder in the range of 5% to 25% as replacement of cement and concrete cube, cylinder and beam strength compared with conventional concrete cubes, cylinder and beam respectively. In these types of work wasteglasses is to be used so the cost will be relatively low when compared with normal concrete. The project work was emphasizing on use of glass materials as partially replacement of cement. Further we extend this research as follows. The outcome of glass materials on compressive strength of concrete as partially replacement of coarse aggregates and fine aggregates can be analyze and studied. The glass powder is the pozzolanic material. For that reason Compressive strength can be analyzed by usingthis materials same as partially replacement of cement in concrete. And also we can determined its optimum dosage range when concrete riches maximum strength. The tensile strength of concrete also can be studied by using glass materials in a concrete.

Keywords: Compressive strength, flexural strength, splitting tensile strength glass powder fly ash.

I. INTRODUCTION

Natural resources are of two types- the renewable and the non-renewable. Renewable resources which can be recycled again and again which are utilized for our benefits. But non- renewable resources are those, which once removed and utilized are lost forever. The major problem facing by mankind today is about the utilization of natural resources in order to meet the human needs and maintain the economic growth without exhausting the resources and endangering the environmental integral on which life economic prosperity and our security depend. The worldwide utilization of regular sand is high because of the broad utilization of cement. Specifically, the interest for regular sand is high in creating nations inferable from quick infrastructural development, buildings and different structures since cement assumes the critical part and a substantial quantum of its being used.Concrete is the 2nd largest of the most widely used materials; but there are environmental issues associated with its use which are needed to be taken under consideration and cannot be ignored. Concrete production uses large quantities of natural resources as aggregates and contributes to the release of carbon dioxide during the production of cement. One ton of carbon dioxide is released into the atmosphere for the production of one ton of cement , which is approximately 7% of the world's total yearly production of CO2 (Meyer, 2004). Concrete is a common construction material in India and its production causes the same environmental concerns as that of regular concrete. In recent years, there has been an increasing incentive to minimize the environmental effect of the construction industry through programs such as the Leadership in Energy and Environmental Design (LEED) Green Building Rating System, which rewards points for sustainable construction practices (CaGBC, 2009). Greater sustainability of the construction industry can be achieved if a portion of the virgin aggregate or cement is replaced with waste materials. Significant experimental work were performed on the use of recycled concrete aggregate to replace virgin aggregate and on the use of pozzolanic materials to be used as partial replacement of cement in concrete, such as fly ash, silica fume and ground granulated blast furnace slag. Due to the successful implementation of these waste materials into regular concrete there is increased desire to find new post-consumer materials which can be used as a partial replacement for cement. The experimental work presented in this research looks at the use of glass, as an ecofriendly material to replace cement in the production of concrete.

II. MATERIALS

Following materials are used in present study

- Cement
- Sand
- Aggregate
- Water
- Waste Glass Powder

Cement

A hydraulic cement made by finely pulverizing the clinker produced by calcining to incipient fusion a mixture of argillaceous and calcareous materials Portland cement is the fine gray powder that is the active ingredient in concrete. For present study 43 grade OPC was used.

Sand

River sand is a widely used construction material all over the world, especially in the production of concrete, cement-sand mortar and concrete blocks. Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. The composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica (silicon dioxide, or $SiO2$), usually in the form of quartz. Locally available river sand was used in present study.

Aggregate

In addition to cement, water and aggregates are the other primary constituents of concrete mixtures. Aggregate is a rocklike material of various sizes and shapes, used in the manufacture of Portland cement concrete, bituminous (asphalt) concrete plaster, grout, filter beds, and so on. The ASTM standards (C125 and D8) define aggregate as a granular material such as sand, gravel, crushed stone, or iron- blast furnace slag used with a cementing medium to form mortar or concrete, or alone as in base course or railroad ballast.

Water

Potable water was used in this study. Water is a crucial component of concrete as it is viably included in chemical responses with cement, particularly hydration. In the present examination consumable water is used according to IS 456: 2000 was used for preparation of cement, the water concrete proportion chooses the quality of cement.

Waste Glass Powder

Waste glass available locally was collected and made into glass powder. Glass waste is very hard material. Before adding glass powder in the concrete it has to be powdered to desired size. Glass is an inert material which could be recycled and used many times without changing its chemical Property. We will crash waste flat glass and prepare it as a powder to be used as cementitous or filler material in concrete mixes. Glass is an amorphous material with high silica content making it potentially pozzolanic when particle size is less than 150 µm.

Table 2.1 Chemical properties of Glass Powder

Chemical Properties of Glass Powder Oxides	Oxides Present In Glass Powder (%)
CaO	11.42
SiO2	72.61
Al2O3	1.38
Fe2O3	9.70
MgO	0.79
Na2O	13.7
K2O	0.43

III.METHODOLOGY

In this experimental investigation an attempt has been made to find out the strength of concrete produced by replacing the cement with waste glass powder in various percentages ranging from 5% to 25% in increments of 5% [0%, 5%, 10%, 15%, 20%, and 25%]. Ordinary Portland cement (OPC) 43 grade, locally available sand and coarse aggregates were used in this experiments. The sand used was a Zone II had the specific gravity 2.6. the specific gravity of the coarse aggregate was 2.59. the coarse aggregate used were of 12mm and down size. The glass powder was obtained by

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 5, Issue 5, May 2018

crushing waste glass pieces in a wardha market. The 150 micron passing fraction was used for the experimentation. Mix design carried out for M20 as per IS 10262:2009 yielded a mix proportion of 1: 1.55: 3.02 with water cement ratio of 0.45. Specimens were prepared according to the mix proportion and by replacing cement with glass powder in different proportion and use of sand. An increasing trend in compressive strength and flexural strength was observed with increasing replacement of cement. To find out compressive strength, split tensile strength and flexural strength specimens of dimensions 150x150x150mm, 150x300mm and 150x150x700mm were cast and tested as per IS 516:1959. Details of mix content with constant coarse aggregate and w/c ratio as shown in Table.

Table 3.1 Quantity of Materials as per Mix Design

WGP replacement	`Mix Propertion (In gm)				W/C 0.5 %
	C (Cement)	S (Sand)	A (Aggregate)	WGP (Waste Glass Powder)	
0 %	400	648	1360	0.00	200
5 %	380	648	1360	20.00	200
10 %	360	648	1360	40.00	200
15 %	340	648	1360	60.00	200
20 %	320	648	1360	80.00	200
25 %	300	648	1360	100.00	200

3.1 COMPRESSIVE STRENGTH TEST

Out of many test applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. For cube test two types of specimens either cubes of 15 cm X 15 cm X 15 cm or 10cm X 10 cm x 10 cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15 cm x 15cm x 15 cm are commonly used. This concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimen should be made even and smooth...These specimens are tested by compression testing machine after 7, 14 and 28 days curing. The compressive strength of concrete is the most common performance measure used in designing buildings and other structures. The compressive strength is generally measured by breaking cubical concrete specimens in a compression-testing machine. The compressive strength is calculated from the failure load divided by the cross-sectional area resisting the load Compressive strength test results are primarily used to determine that the concrete mixture as delivered meets the requirements of the specified strength, fck in the jobs specification. The test was conducted on the cube specimen of size 150×150×150mm.

Compressive Strength = Failure Load / Cross Sectional Area of Cube

3.2 SPLIT TENSILE STRENGTH

This test method consists of applying a diametral compressive force along the length of a cylindrical concrete specimen at a rate that is within a prescribed range until failure occurs. Splitting tensile strength is generally greater than direct tensile strength and lower than flexural strength (modulus of rupture).

Procedure

Marking

Draw diametral lines on each end of the specimen using a suitable device that will ensure that they are in the same axial plane

Measurements

Determine the diameter of the test specimen to the nearest 0.01 in. [0.25 mm] by averaging three diameters measured near the ends and the middle of the specimen and lying in the plane containing the lines marked on the two ends. Determine the length of the specimen to the nearest 0.1 in. [2 mm] by averaging at least two length measurements taken in the plane containing the lines marked
on the two ends.

Positioning Using Marked Diametral Lines

Center one of the plywood strips along the center of the lower bearing block. Place the specimen on the plywood strip and align so that the lines marked on the ends of the specimen are vertical and centered over the plywood strip. Place a second plywood strip lengthwise on the cylinder, centered on the lines marked on the ends of the cylinder.

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 5, Issue 5, May 2018

Rate of Loading

Apply the load continuously and without shock, at a constant rate within the range 100 to 200 psi/min [0.7 to 1.4 MPa/min] splitting tensile stress until failure of the specimen

Calculation

Calculate the splitting tensile strength of the specimen as follows:

$$T = 2.P / \Pi.l.d$$

where:
T= splitting tensile strength, psi [MPa]
P= maximum applied load indicated by the testing machine, lbf [N],
l= length, in. [mm], and
d= diameter, in. [mm]

3.3 FLEXURAL STRENGTH

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending.

The test specimen shall have approximate dimensions of 6 in. x 6 in. x 20 in. (152 mm x 152 mm x 508 mm). The test specimen shall be kept wet until the time of the test.

1. Prepare the test specimen by filling the concrete into the mould in 3 layers of approximately equal thickness. Tamp each layer 35 times using the tamping bar as specified above. Tamping should be distributed uniformly over the entire cross section of the beam mould and throughout the depth of each layer.
2. Clean the bearing surfaces of the supporting and loading rollers , and remove any loose sand or other material from the surfaces of the specimen where they are to make contact with the rollers.
3. Circular rollers manufactured out of steel having cross section with diameter 38 mm will be used for providing support and loading points to the specimens. The length of the rollers shall be at least 10 mm more than the width of the test specimen. A total of four rollers shall be used, three out of which shall be capable of rotating along their own axes. The distance between the outer rollers (i.e. span) shall be **3d** and the distance between the inner rollers shall be **d**. The inner rollers shall be equally spaced between the outer rollers, such that the entire system is systematic.
4. The specimen stored in water shall be tested immediately on removal from water; whilst they are still wet. The test specimen shall be placed in the machine correctly centered with the longitudinal axis of the specimen at right angles to the rollers. For moulded specimens, the mould filling direction shall be normal to the direction of loading.
5. The load shall be applied at a rate of loading of 400 kg/min for the 15.0 cm specimens and at a rate of 180 kg/min for the 10.0 cm specimens.

The Flexural Strength or modulus of rupture (f_b) is given by

$$f_b = pl/bd^2$$ (when **a**> 20.0cm for 15.0cm specimen or > 13.0cm for 10cm specimen)

or

$$f_b = 3pa/bd^2$$ (when **a**< 20.0cm but > 17.0 for 15.0cm specimen or < 13.3 cm but > 11.0cm for 10.0cm specimen.)

Where,
a = the distance between the line of fracture and the nearer support, measured on the center line of the tensile side of the specimen
b = width of specimen (cm)
d = failure point depth (cm)
l = supported length (cm)
p = max. Load (kg)

IV. RESULT

Following results were obtained on designed concrete mix having specified percentage of Waste Glass Powder.

Table. 4.1 Compressive Strength Result

Sr. No.	WGP replacement	Avg. Strength After 7 Days (N/mm^2)	Avg. Strength After 14 Days (N/mm^2)	Avg. Strength After 28 Days (N/mm^2)
1	0%	12.23	14.68	23.48
2	5%	13.85	16.62	26.59
2	10%	14.84	18.25	29.20
4	15%	17.27	20.72	33.16
5	20%	15.28	18.34	29.34
6	25%	12.14	14.57	23.31

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 5, Issue 5, May 2018

Table. 4.2 Split Tensile Strength Result

Sr. No.	WGP replacement	Avg. Strength After 7 Days (N/mm^2)	Avg. Strength After 14 Days (N/mm^2)	Avg. Strength After 28 Days (N/mm^2)
1	0%	1.10	1.36	2.25
2	5%	1.25	1.54	2.55
2	10%	1.34	1.69	2.80
4	15%	1.55	1.92	3.18
5	20%	1.58	2.10	3.29
6	25%	1.09	1.35	2.23

Table.4.2 Flexural Strength Result

Sr. No.	WGP replacement	Avg. Strength After 28 Days (N/mm^2)
1	0%	1.57
2	5%	1.77
2	10%	1.95
4	15%	2.21
5	20%	1.96
6	25%	1.55

V. CONCLUSION

Test result on the specimen shows there is improvement in compressive strength because of continuous increase of waste glass powder. The strength increases with addition of waste glass powder at 5%, 10% 15% and after that declines at 20% and 25% gradually because of more alkali silica reaction freed during hydration of cement.

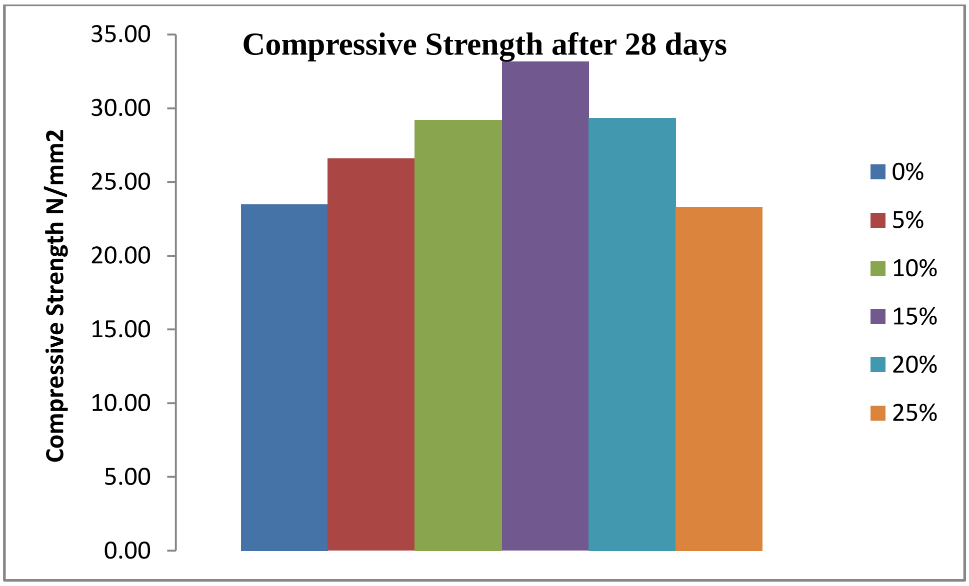

Fig. 5.1 Compressive Strength after 28 days

The aftereffects of split tensile strength of concrete mixes by partial substitution of cement by waste glass powder and utilizing of M-sand as fine aggregate was tested at 7, 14 and 28 days. Thus result tensile of concrete increases with expansion in rate of waste glass powder which can be supplanted up to 20% as indicated in graphical representation.

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 5, Issue 5, May 2018

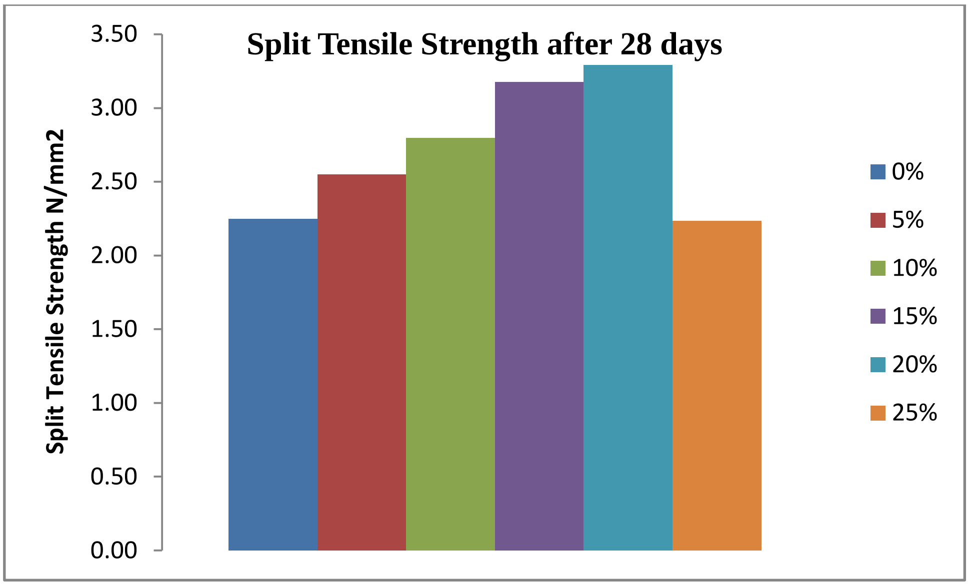

Fig. 5.2 Split Tensile Strength after 28 days

The consequences of flexural strength of concrete mix M 20 by fractional supplanting of cement with waste glass powder were tested at 28 and 56 days, the concrete with addition of 5%, 10% and 15% of waste glass powder demonstrated most extreme strength when contrasted to conventional concrete.

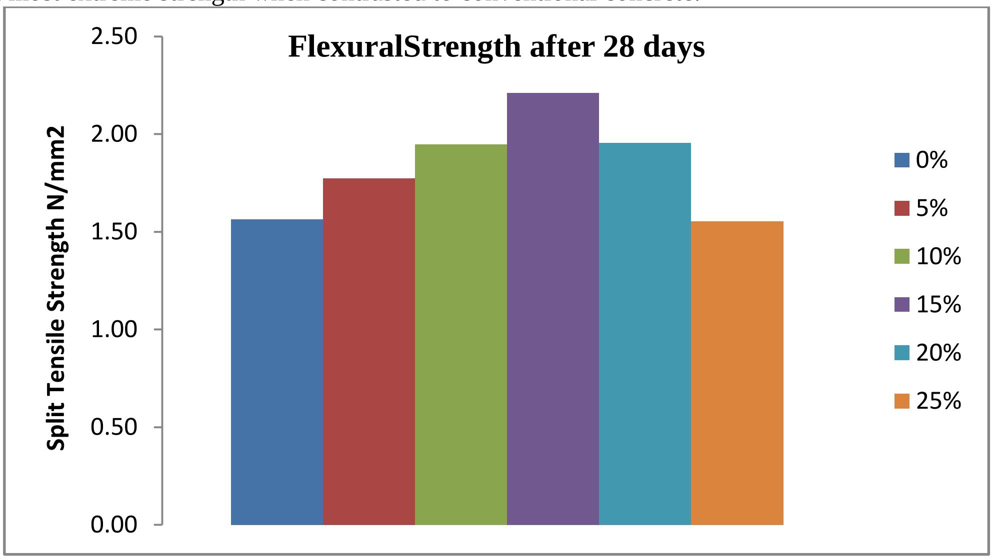

Fig. 6.9 Flexural Strength after 28 days

The increase in strength up to 15% replacement of cement by waste glass powder may be due to pozzolanic reaction of glass powder and it may be due to the glass powder effectively filling the voids and giving rise to dense concrete microstructure. However, beyond 20% the dilution effect takes over and the strength starts to drop. Thus it concludes that 20% was the optimum level for replacement of cement with glass powder.

REFERENCES

[1] Shayan Ahmad "Value-added Utilisation of Waste Glass in Concrete" Iabse Symposium Melbourne 2002, pp. 1-11
[2] Cesar David Verdugo "Effect of Glass Powder on Various Properties of
[3] 3.Concrete" International Journal of Science,Engineering and Technology, 2016, Volume 4 Issue 4, pp 567-573
[4] 4 . Dr. Hassan H. Jony "The Effect of Using Glass Powder Filler on Hot Asphalt Concrete Mixtures Properties" American Journal of Engineering Research (AJER) Volume -7, Issue - 1, pp – 336 -345
[5] Ion Dumitru, Tony Song "Field Trials Using Recycled Glass as Natural Sand Replacement and Powdered Glass as Cementitious Materials Replacement in Concrete Pavement" International Journal of Science,Engineering and Technology, 2016, Volume 6 Issue 4, pp 565-571
[6] Vanjare and Shriram "Experimental Investigation on Self Compacting ConcreteUsing Glass Powder" International Journal of Engineering Research and Applications Vol. 2, Issue 3, May-Jun 2012, pp.1488-1492
[7] Vasudevan "Performance of Using Waste Glass Powder In Concrete As Replacement Of Cement"American Journal of Engineering Research (AJER), 2013 Volume - 02, Issue -12, pp-175 – 181